RED RIVER DATA

Results Of The Region 6, 1989 Biomonitoring Demonstration Projects

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Mark,
There is data on Red River, NM
in here from years ago.
Chuck if you don't want it

U.S. EPA REGION 6 AMBIENT TOXICITY TESTING DEMONSTRATION PROJECTS

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April, 1990

AMBIENT TOXICITY TESTING DEMONSTRATION PROJECTS. M. Bastian, W. Lane, P. Koska and C. Young, USEPA, Dallas, Texas; T. Hollister, USEPA, Houston, Texas: B. Trebatoski, Texas Water Commission, Corpus Christi, Texas; L. Smolka, New Mexico Environmental Improvement Division, Santa Fe, New Mexico and D. Butler, Oklahoma Conservation Commission, Oklahoma City, Oklahoma.

A number of ambient toxicity surveys have been conducted by USEPA Region 6 in cooperation with state agencies in Texas, Oklahoma and New Mexico. The purpose of the surveys was to demonstrate and encourage toxicity testing in state water quality monitoring programs. Water and sediment samples were collected from twenty-four sites on seven streams to assess toxicity from point and non-point sources Streams were located in diverse ecological areas ranging from the Western Gulf Coastal Plain to the Arizona/New Mexico Plateau. Water samples were assayed with combinations of fathead minnow embryo-larval and Ceriodaphnia seven day tests or the fathead embryo-larval test and Daphnia 48 hour acute tests. Eluates were prepared from the sediments and assayed with fathead minnow embryo-larval and Daphnia acute tests. Water and sediment samples were chemically analyzed for toxicants as part of the Texas and New Mexico surveys. Phytoplankton and periphyton assemblages were evaluated for the Oklahoma survey. These groups as well as fish and benthic macroinvertebrates were evaluated as part of the Texas and New Mexico surveys. Toxicity test results will be compared with chemical analyses and the condition of the instream community. Suggestions for the use of toxicity testing in water quality monitoring programs will be presented.

RED RIVER

The Red River is one of the major recreational streams in northern New Mexico. This stream is designated as a cold water fishery in the state water quality standards. It supports a reproducing trout fishery except in its middle reach from the town of Red River to the New Mexico Game and Fish Department fish hatchery near Questa. Citizens have expressed concerns about this limitation to the aquatic life use and there have been several studies to evaluate the causes of impairment to the stream (Garn, 1984: Jacobi and Smolka, 1984; Smolka and Jacobi, 1986; Smolka and Tague, 1987). Public concern has often focused on the effect of Molycorp, a molybdenum mine, on water quality. Between 1976 and 1985 when the mine was in operation there are 31 documented breaks in a slurry line that runs from the ore processing plant and slurry waste ponds. The mine is currently non-operational for economic reasons. The slurry line runs along Red River and upgradient from the streambed. It has been hypothesized that solids released during breaks in this line have filled in the cobble substrate and introduced toxic sediments to the stream.

The New Mexico Environmental Improvement Division (NMEID) conducted three surface water surveys and a groundwater seepage study of the stream between September 13 and October 25, 1989. Staff from the Environmental Services Division of Region 6 participated in a surface water survey during September 20-24, 1989. The objectives of this series of surveys was to evaluate the chemical quality of water and sediment, water and sediment toxicity, the condition of the biological community, and the quantity of groundwater influx to the stream.

The NMEID produced a report about this survey. Data and interpretation from that report are presented here as they relate to the evaluation of toxicity.

SITE DESCRIPTION

The Red River is a high gradient mountain stream in the Sangre de Cristo Mountains of north central New Mexico. The stream flows from its headwaters on Wheeler Peak at an elevation of 12500 feet North and West for 35 miles until its confluence with the Rio Grande 6500 at feet. Red River is located in the Southern Rockies Ecoregion which is characterized by mountains and tablelands with high relief, spruce/fir forests and mountain meadows (Figure 1-1). The predominant land uses are as forests and grazing land.

The sampling stations are described in Table 4-1 with respect to river mile, substrate and flow. Figure 4-1 is a schematic representation of the system. Several stations require further explanation for interpretation of the survey results. Station 1

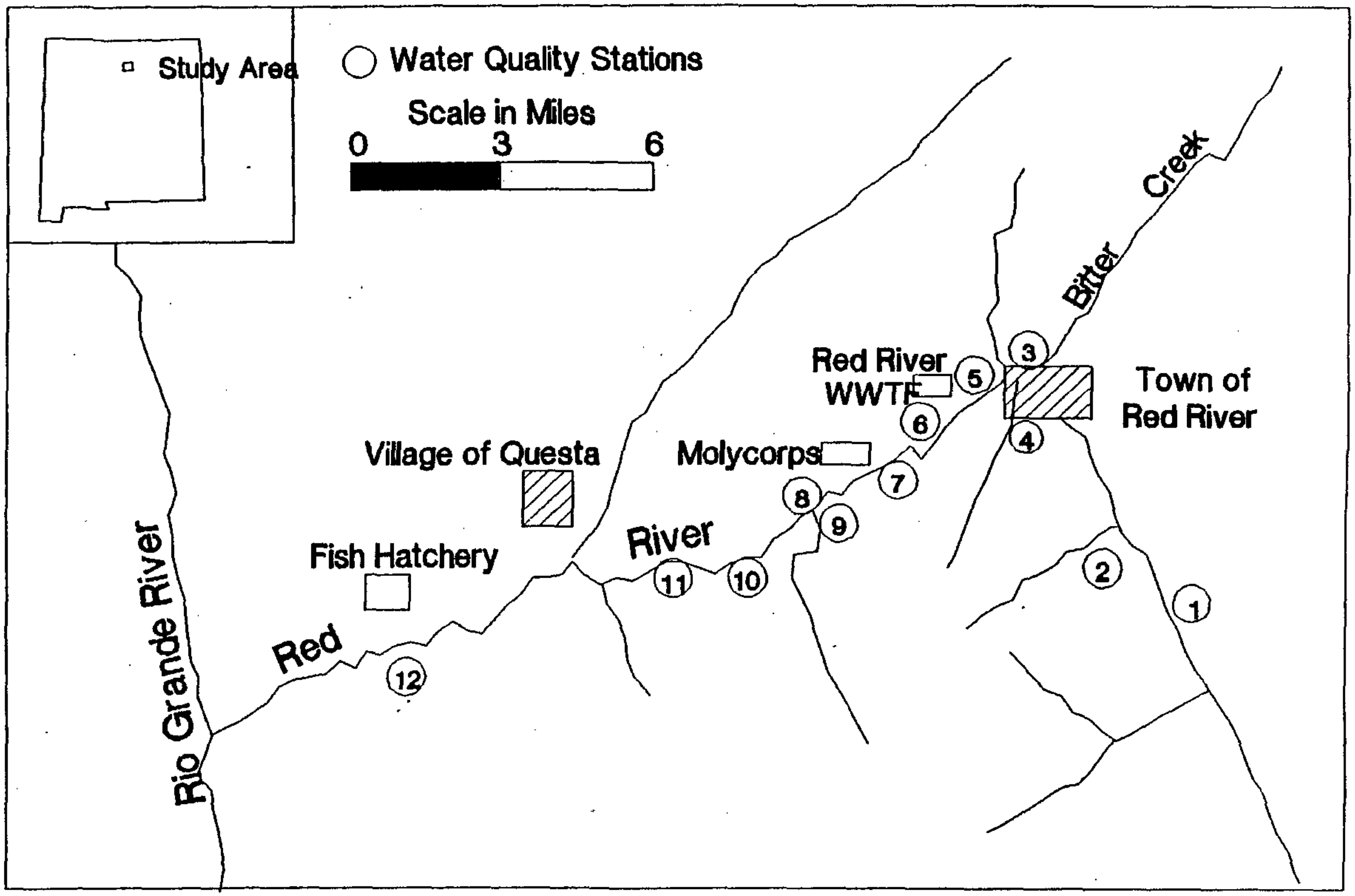


Figure 4-1. Red River, Taos Co., New Mexico.

Table 4-1. Relative locational and substrate description of the Red River Sampling Sites.

STATION NUMBER	RIVER MILE	SUBSTRATE	FLOW (CFS)*
1	24.1	BOULDER-RUBBLE ORGANIC LITTER	11
3	22.1	RUBBLE-GRAVEL SAND/SILT	
5	21.1	RUBBLE-GRAVEL	
6	17.6	RUBBLE-LEAF LITTER	16
8	13.2	RUBBLE-SAND/ SILT	19
11	9.0	RUBBLE-SAND/ SILT	30

* Flow measured during seepage study on 10/25/88. Representative of seasonal dry weather conditions.

toxicity tests were conducted on water samples and sediment sediments from the same stations . Additionally, on-site solid phase sediment toxicity tests were conducted with samples from stations 1, 6, 8, and 11 at the Red River Fish Hatchery. Rainbow trout (Salmo gairdneri) provided by the hatchery were used as test organisms. Fry were approximately 4 months old and weighed an average of 0.412 grams. The Procedures used in these tests followed the guidelines for acute toxicity tests and sediment toxicity tests recommended in Peltier and Weber (1985) and Nebeker et.al. (1984).

The solid phase tests were begun by filling one gallon glass jars volumetrically with one part sediment to four parts water. Test water was culture water used in the hatchery rearing troughs. Four replicate jars were prepared per each station in this manner. An additional set of jars were filled with culture water only and used as a performance control. Jars were set in a flow through rearing trough in a randomized block design and left unaerated overnight to allow sediments to settle. The next day the jars were gently aerated this was continued for the duration of the test. After one hour the temperature, pH,dissolved oxygen and conductivity was checked in each jar. Dissolved oxygen in all vessels was greater than 73% and 5 fry were added to each replicate in a random fashion. Fry were not fed for 24 hours prior to test initiation to limit handling stress and were not fed during the 48 hour test period. The test solutions were maintained at a constant 12 C by flow through water bath. The loading rate in each jar was 0.6 grams per liter which is less than the maximum recommended loading rate for cold water tests of 0.8 grams per liter.

Water quality and mortality was checked every eight hours. After 48 hours the test was terminated. Fry were collected, their condition was observed and the organisms were discarded.

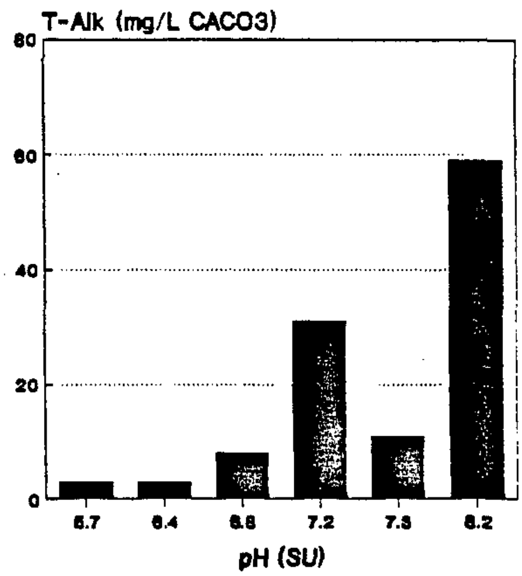
RESULTS

Water Chemistry

The water at all stations was cool, well oxygenated, moderately hard and moderately conductive (Table 4-3). However, there were some striking differences in water quality between wet weather flows on September 13 and dry weather flows on September 20 at stations 3-11. Turbidity and total suspended solids increased by two orders of magnitude, pH decreased as much as 1.9 S.U. and alkalinity dropped dramatically. The increase in solids concentration and decrease in pH was not detected at station 1. Stations 3-11 are located in the area of the stream which receives sulfide-rich soils from erosional cuts or arroyos on the northern slope of the canyon; station 1 is located upstream from this area. The pH in Bitter Creek (station 3) on September 13 was measured at 5.7 S.U. and violated the New Mexico criteria for

Figure 4-2.

pH vs. T-Alk
9-13-88



pH vs. T-Alk.
9-20-88

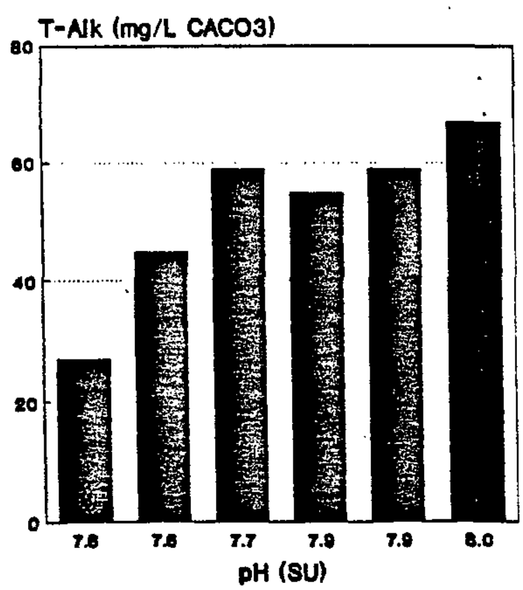


Table 4-3. Red River Ambient Water Quality

Parameter	1	3	5	6	8	11
Cond.(uohmmo)	109 118	130 98	195 146	171 151	229 173	230 210
pH (SU)	8.2 8.0	5.7 7.6	6.4 7.7	7.2 7.9	7.3 7.9	6.6 7.6
T-Alk. CaCO3 (ug/L)	59 67	3 27	3 59	31 59	11 55	8 45
Hardness CaCO3 (ug/L)	123 158	93 98	153 208	153 163	213 178	183 198
TSS (mg/L)	37 3	197 3	234 3	304 5	884 14	927 17

Dual values are for 9/13 and 9/20 samplings

Table 4-4. Ambient Water Chemistry Total Metals (ug/L)

PARAMETER		STATION 1	3	5	6	8	11
Cu	(9/13)	-	140	80	60	110	130
	(9/20)	-	-	-	-	-	-
Fe		1000	17000	20000	20000	45000	45000
		-	740	240	410	1000	590
Mn		-	340	390	360	740	1300
		-	-	60	60	110	600
Zn		-	-	110	50	180	300
		-	-	-	-	-	100
Al		700	5100	7300	5300	12000	17000
		-	500	200	200	800	2000

(- below detection limit of 50 ug/L)

Table 4-5. Ambient Water Chemistry Dissolved Metals (ug/L)

PARAMETER		STATION 1	3	5	6	8	11
Cu	(9/13)	-	-	-	-	-	-
	(9/20)	-	-	-	-	-	-
Fe		-	-	100	-	-	-
		-	240	-	-	-	-
Mn		-	190	300	210	390	800
		-	-	60	-	80	610
Zn		-	70	150	-	-	70
		-	-	-	-	-	120
Al		-	100	100	70	70	70
		-	260	50	50	120	50

(- below detection limit of 50 ug/L)

83

000196

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The potential for these acidic conditions is shown by the drop in alkalinity during the September 13 sampling (Figure 3). The pH did not drop as dramatically as during previous storm events but the alkalinity or buffering capacity was almost completely consumed at stations 3 and 5 and largely depleted at stations 8 and 11.

Many metals in the dissolved and total phases were non-detectable. Concentrations of total copper, iron, manganese, aluminum and zinc did increase, at most stations, during the wet weather event (Table 3). Increases were greatest for total phase aluminum and zinc which are major constituents of area soils. By contrast, dissolved metal concentrations did not differ greatly between the September 13 and 20 samples. The exception is manganese that was mobilized in the dissolved phase during the storm flow. Dissolved metals were not measured at concentrations that would be predicted to be toxic during these sampling events (EPA Water Quality Criteria. 1986).

<u>Sediment Chemistry</u>

Eluates prepared with sediments from stations 3-11 were slightly acidic (5.6-6.7 S.U.) while the eluate prepared with the station 1 sample was slightly basic (7.2 S.U.). The lowest pH (5.6) was measured in the station 3 (Bitter Creek) eluate; the station with the lowest pH during storm flows. All eluates were moderately conductive.

Most sediment metals which were extracted by the elutriate phase toxicity procedure (mixed with deionized water amended to pH 5 and shaken for 24 hours) were not available in measurable quantities. Aluminum, manganese and zinc were detectable and were the metals most frequently measured as dissolved species in the storm flow samples. These laboratory results support the conclusion of Smolka and Tague (1986) that metals are mobilized into the dissolved phase by the acidic conditions during high flow events.

<u>Toxicity Testing</u>

None of the water samples were toxic in the 48 hour <u>Daphnia</u> tests or the eight day fathead minnow test (Table 5). The eluate prepared with Station 3 sediment caused 60% mortality in the <u>Daphnia</u> test. This mortality is attributed to the low pH (5.6) of the eluate. None of the eluates produced a significant

Table 4-6. Stream Sediment Chemistry for Total Metals (ug/L)

PARAMETER	STATION 1	3	6	11
Mn	370	110	360	1110
Zn	160	80	110	110
Al	1076	80	<50	680

Table 4-7. Toxicity Test Results for Ambient Water.

STATION	D. pulex 48-hr mortality (%)	Fathead 7-day embryo/larva (% mortality)
Control	0	5
1	5	0
3	5	10
5	5	5
6	0	15
8	0	0
11	0	5

57

Table 4-8. Toxicity Test Results Sediments

Station	D. pulex 48-hr mortality (%)	Fathead 7-day embryo/larva mortality (%)	Trout 48-hr mortality (%)
Control	5	5	0
1	0	10	0
3	60	20	
5	0	5	
6	0	0	0
8	0	10	0
11	5	15	0

response in the fathead minnow test.

There was no mortality to the trout fry in the solid phase tests conducted at the fish hatchery (Table 5). However, there were differences in fish behavior and appearance among the treatments. Fish exposed to station 1 sediments and the culture water control rested on the sediment surface or the bottom of the jar. Fish exposed to sediments from stations 6,8 and 11 were not observed resting on the sediment; their movement agitated the sediments and kept the solutions fairly turbid. These fish were much lighter in color and their gills appeared more red, indicating greater irritation, in the post exposure evaluation. These observations are anecdotal and are not interpreted as significant signs of stress but raise the question about sediment toxicity to trout with longer exposure periods.

Biota

The biological community is seriously impacted in the middle reach of the Red River. Decreases in abundance (<62%), genus richness (<50%), and diversity (<26%) of benthos were noted between stations 1 and 5 and again between stations 7 and 11. The abundance, richness and diversity at station 11 were 8%, 21% and 55% of station 1 values. The number of periphyton species dropped 50% and diversity decreased 65% between stations 7 and 10. Fish abundance became the only meaningful measure of the fish community, when electroshocking collected a maximum of three species. Abundance fell 87% between stations 1 and 6 and showed a severe impact at station 11 where no fish were collected.

Comparisons of Chemical, Toxicity and Biological Collections

There appear to be associations between TSS, alkalinity and the health of the biological community. For example the number of benthos genus was inversely related to the TSS measured during high flow conditions (Figure 3). In other words, as the solids loading during storm events increases, the potential for embedding the rubble substrate increases and reduces important stream habitat. This was visually evident in our qualitative evaluations of the impacted stream segments. The number of benthos species was also directly related to the alkalinity during high flow (Figure 4). This relationship indicates that at locations where the buffering capacity is depleted during these episodic events the subsequent acidic conditions may eliminate species.

The inverse relationship between TSS and fish abundance and a direct relationship between alkalinity and fish abundance is also shown in Figures 5 and 6. Solids loading which embeds the substrate and the episodic drops in pH appear to be major limitations to the health of the biological community.

The toxicity results provide direct and indirect evidence that toxicity is largely limited to high flow conditions. The direct evidence is that the one positive result was associated with the acidic eluate of Bitter Creek sediments, a Red River tributary and major source of runoff flow. The indirect evidence is that the water and sediments collected from the mainstem under normal flow conditions were not toxic.

Table 4-9. Benthic Macroinvertebrate Analysis

	STATION				
PARAMETER	1	5	6	7	11
Abundance	2038	771	997	1275	171
# of genera	28	14	16	16	6
Diversity	3.77	2.79	2.92	2.82	2.06

Table 4-10. Fish Collection Analysis

PARAMETER	STATION 1	6	11	Above Red River Hatchery
Population (per 100 m)	45	6	0	49
species	3	2	0	2

Table 4-11. Diatom Analysis

PARAMETER	STATION 1	6	7	10
Species	18	20	18	9
Diversity	3.54	3.91	3.56	1.26

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Figure 4-3. TSS vs. # taxa macroinvertebrates

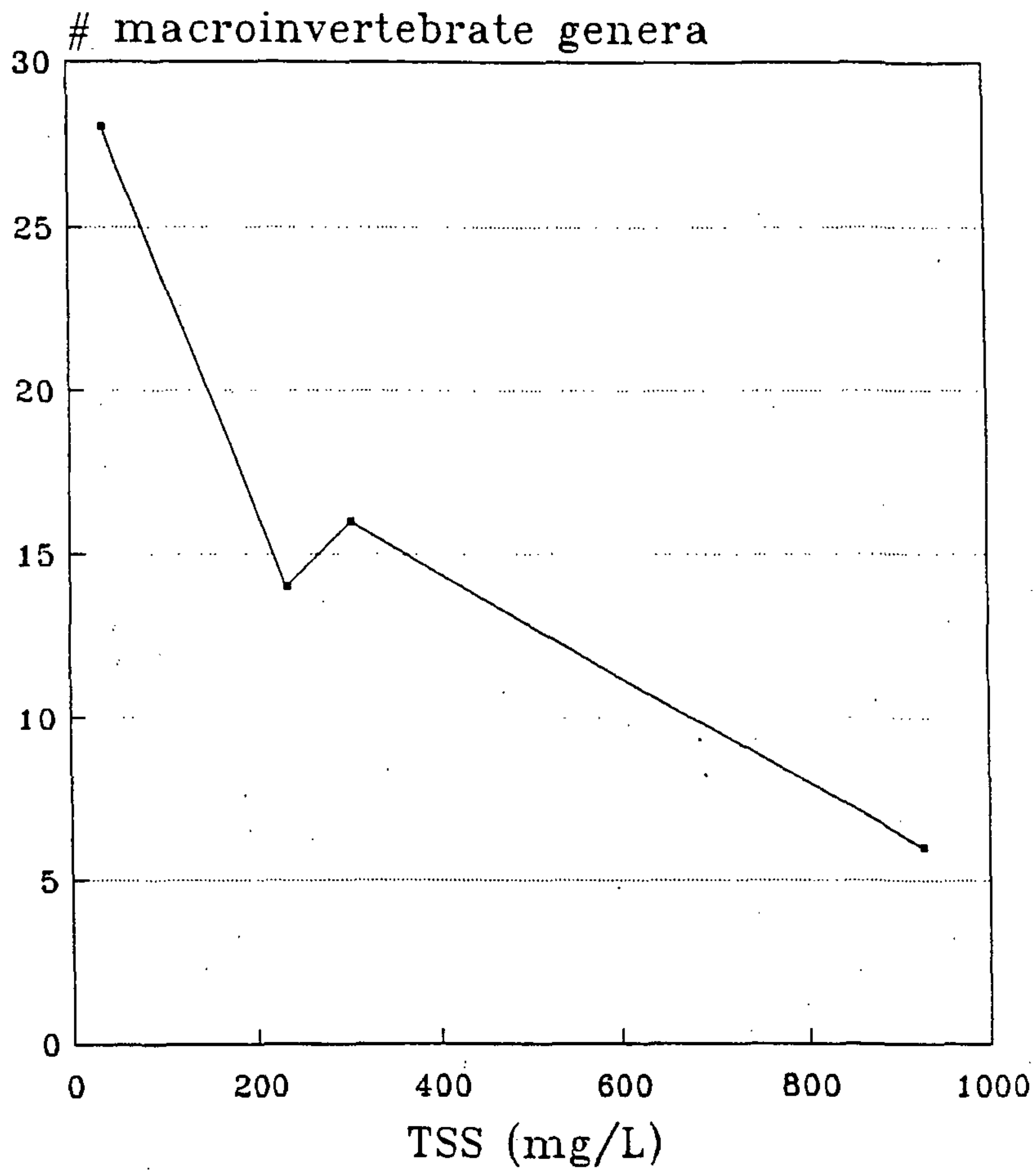

Figure 4-4. TSS vs. Fish Abundance

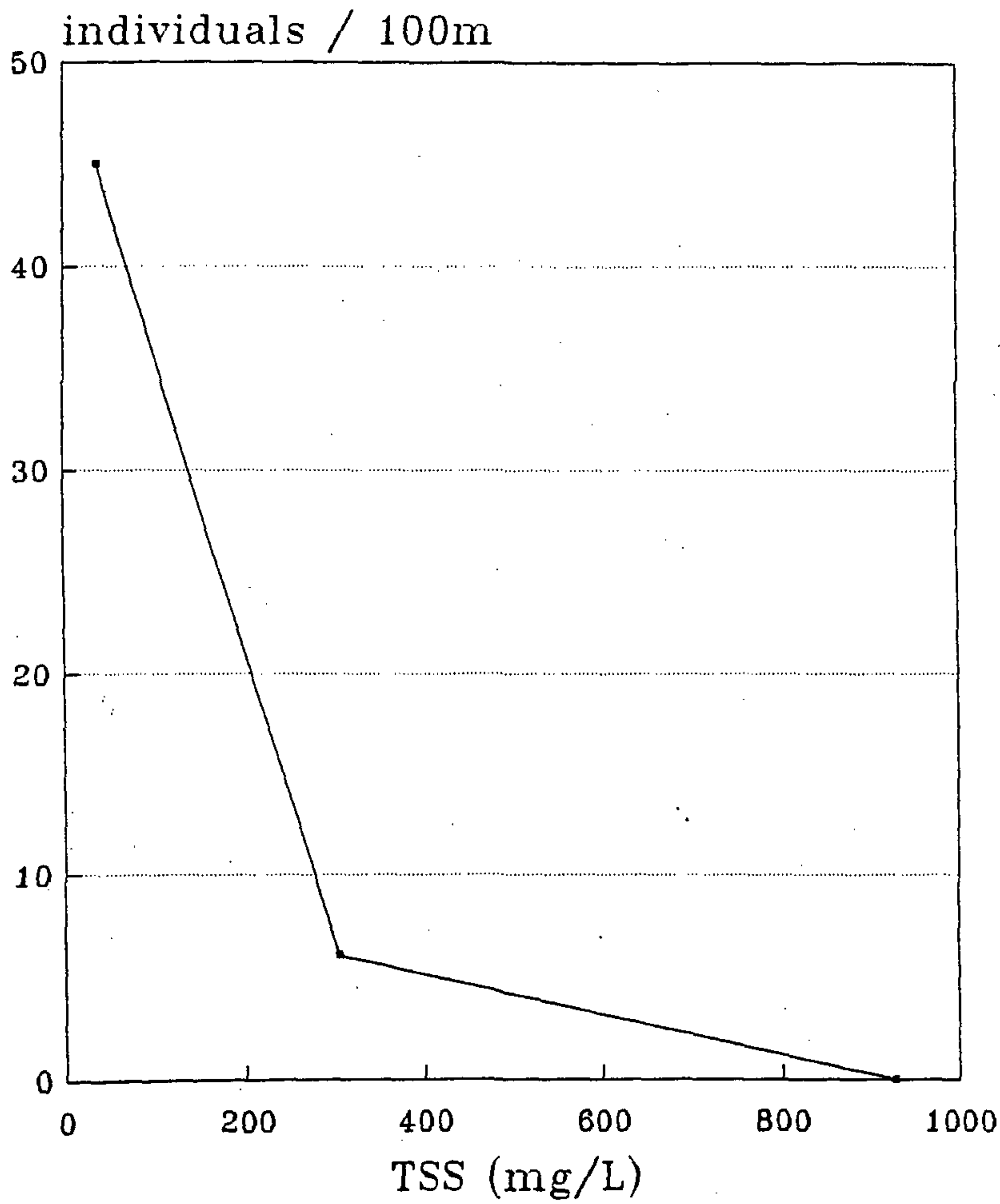

Figure 4-5. T-Alk vs # Taxa macroinvertebrates

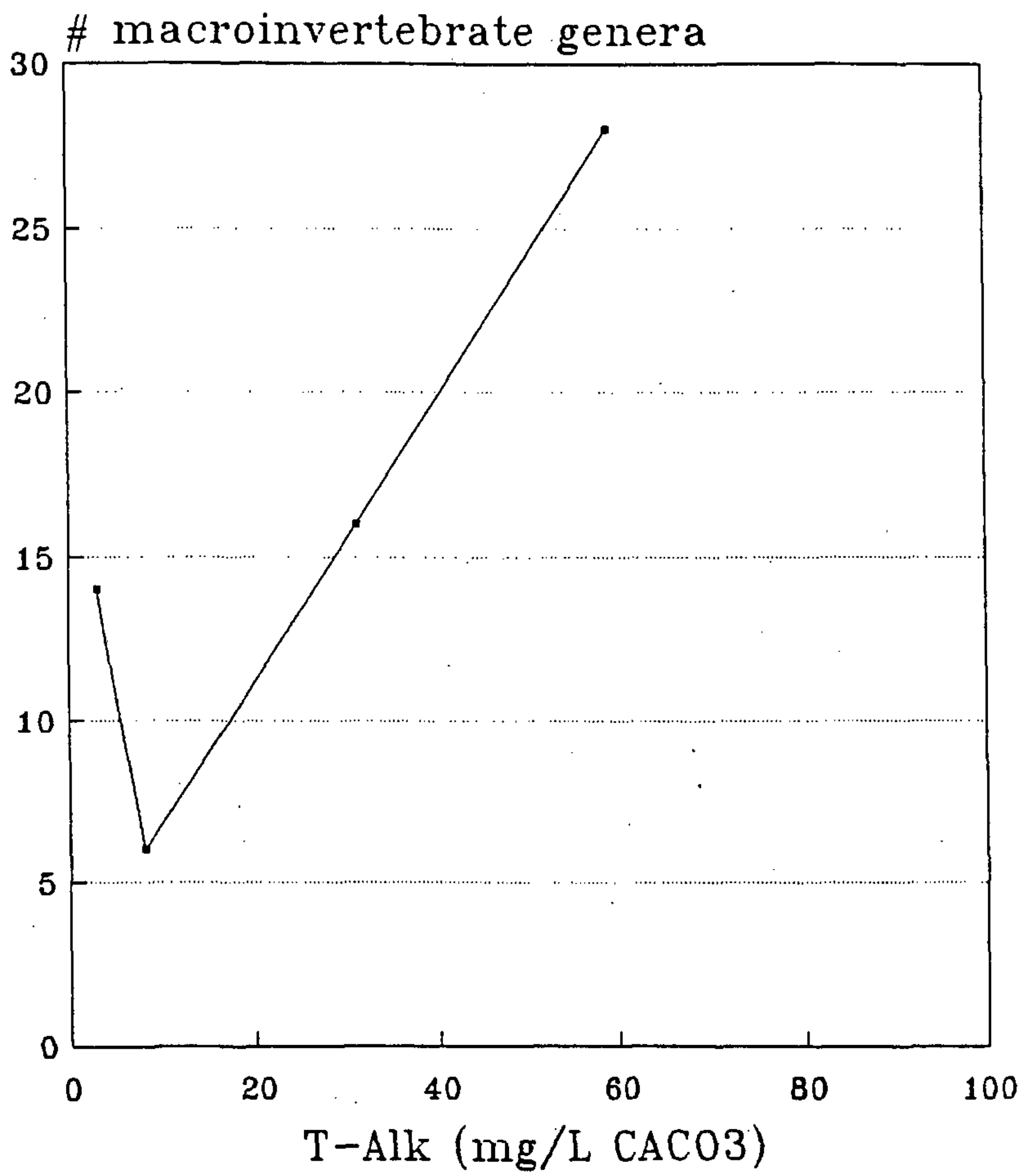

Figure 4-6. T-Alk vs. Fish Abundance